ORIGINAL ARTICLE

Evaluating the Efficacy of Intravenous Atropine in Preventing Spinal Anaesthesia-Induced Hypotension in Lower Abdominal Surgery: A Controlled Study

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ABSTRACT **Background:** Spinal anesthesia-induced hypotension is a frequent complication that can lead to significant morbidity and even mortality if not promptly detected and addressed. This study evaluated the effect of intravenous atropine on the incidence of spinal anesthesia-induced hypotension in patients undergoing lower abdominal surgery.

Methods: This prospective, randomized, double-blinded study recruited 130 adults with American Society of Anesthesiologists physical status I or II who underwent elective lower abdominal surgeries under spinal anesthesia at the Federal Teaching Hospital (formerly Federal Medical Centre) Lokoja in Kogi State, Nigeria. Participants were randomly assigned to receive either a placebo of 1ml of 0.9% saline or 1ml of 0.6mg intravenous atropine, 1 minute post induction of spinal anesthesia. Haemodynamic parameters including blood pressure, mean arterial pressure (MAP), and oxygen saturation were measured and recorded throughout the study. Statistical analysis was done using SPSS version 22. Student t-test was used to compare the change in mean arterial pressure between the two groups and chi square for categorical data. Probability value less than 0.05 was considered as statistically significant.

Results: The incidence of hypotension was significantly lower in the atropine group (6.8%) compared to the normal saline group (19.6%; $p = 0.041$). Although fewer patients in the atropine group required multiple doses of ephedrine, this difference was not statistically significant ($p = 0.152$). Tachycardia occured more frequently in the atropine group (54.2% vs.14.3%, $p < 0.001$), and all cases of dry mucous membrane occurred in the atropine group ($p = 0.004$).

Conclusion: Intravenous atropine (0.6mg) administered 1 minute after spinal anesthesia induction significantly reduces the incidence of spinal anesthesia-induced hypotension in patients undergoing lower abdominal surgery, but comparatively the severity was not clinically relevant.

Keywords: Intravenous Atropine, Spinal Anaesthesia, Hypotension, Lower abdominal surgery and prevention.

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INTRODUCTION

Spinal anesthesia is widely used for lower abdominal surgeries due to its simplicity, rapid onset, cost effectiveness, reduced morbidity and mortality[1-4]. However, a major limitation is the frequently associated spinal anaesthesia induced hypotension (SAIH) that is primarily due to sympathetic blockade and unopposed parasympathetic activity.[5, 6]

The incidence of this spinal anesthesia-induced hypotension (SAIH) can be as high as 33-80% in studied populations.[6-8] Current preventive strategies like fluid

preloading, administration vasopressors, and leg compression, have all shown limited successes, but the incidence remains significantly high. Hence there is a search for a technique or combinations of techniques that effectively prevent spinal anaesthesia induced hypotension.[9,10] Atropine, an anticholinergic agent, may provide haemodynamic benefit by increasing heart rate and cardiac output.[11-13]

Given its socioeconomic and pharmacologic benefits, atropine could be a valuable addition to the management of spinal anaesthesia induced hypotension, particularly in resource-constrained settings, where there is limited supply of essential and lifesaving drugs. This study investigates the efficacy of prophylactic intravenous atropine in reducing the incidence of spinal anaesthesia induced hypotension in patients undergoing lower abdominal surgery. Atropine's potential to prevent blunted reflex tachycardia and increase cardiac output makes it an attractive option for preventing hypotension.

METHODOLOGY

This prospective, randomized, double blinded, controlled study was carried out at Federal Teaching Hospital (formerly Federal Medical Centre) Lokoja in Kogi State, Nigeria, over a 12-month period. The aim was to evaluate the effect of intravenous atropine for prevention of spinal anaesthesia induced hypotension in patients undergoing elective lower abdominal surgery under spinal anaesthesia.

Following ethical approval from the hospital's Research Ethics Committee, a total of 130 adult patients aged 18-60 years classified as American Society of Anesthesiologists (ASA) physical status I or II were enrolled into this study. Using standard deviation values from a similar study by Sigdel,[7] and taking into consideration an attrition rate of 10%, the sample size was calculated at 65 patients per group, resulting in a total of 130 patients. Furthermore, all participants provided written informed consent prior to their inclusion into this study.

Patients were excluded if they declined participation in the study, fell into the category of patients on beta-adrenergic blockers therapy, with history contraindicating spinal anaesthesia technique, or allergic to atropine. All obstetric patients, those with failed or patchy neuraxial block, has uncontrolled systemic hypertension (defined as systolic blood pressure > 140mmHg or diastolic blood pressure >100mmHg), cardiac arrythmias, conducting abnormality (heart blocks), unstable angina or cardiomyopathy were also excluded from the study.

Randomization was performed using a blocked random allocation sequence generated in stata 13.0. Thirteen random permuted blocks of 10 ensured equal distribution of participants between the two groups. Allocation was concealed using sequentially numbered, sealed opaque envelopes. Each eligible patient selected from an envelope which assigned them either into the atropine group (Group A) or normal saline group (Group N). Both patients and investigators were blinded to group assignments. The study drugs were prepared in identical 2ml syringes (containing 1ml of either 0.6mg atropine or 0.9% saline) by a designated staff member not involved in outcome assessment.

Preoperative assessment was done a day prior to surgery in the ward. On the day of surgery, all patients were pre-hydrated with 10-15ml/kg of 0.9% saline and maintenance infusion with 6-10ml/kg/hr. Spinal anaesthesia was then performed in sitting position at the L3/L4 interspace using 25G Quincke spinal needle with a 3ml volume of 0.5% hyperbaric bupivacaine injected into the subarachnoid space. One minute post injection, Group A received 0.6mg intravenous atropine, while Group N received 1ml of 0.9% normal saline. Sensory block height was assessed in the midline by pin prick using a sterile hypodermic needle and surgery commenced only when sensory blocked level of T_6 was achieved. Vital signs including pulse rate (PR) and mean arterial pressure (MAP) were recorded every minute in the first 10minutes then every 2minutes in the next 10minutes and then every 5minutes till the end of surgery. Arterial Oxygen saturation and electrocardiographic tracing were continuously monitored. Urine output was monitored every hour with urethral catheter and urine bag while blood loss was estimated by the number of soaked swabs, abdominal packs used plus amount of blood in the suction bottle. Hypotension was defined as the fall in MAP 20% below baseline [and the number of patients who developed this] was recorded as incidence of hypotension for each group.

Patients who developed hypotension were treated with intravenous 500 ml bolus fluid of 0.9% saline, followed by intravenous ephedrine 6 mg if required. The severity of hypotension was determined by the number of patients that required more than one dose of ephedrine given to treat hypotension in each group.

Patients who developed bradycardia (pulse rate < 60 beat per minute) during the study were treated with intravenous atropine 0.6mg. Such patients were excluded from the study, while those with failed spinal anaesthesia or partial block were converted to General anaesthesia and excluded from the study.

The side effects of atropine like dry mucous membranes, tachycardia, dilated pupils, cutaneous flush, rise in body temperature, blurred vision, drowsiness and confusion[11, 12, 13] were looked out for and treated appropriately throughout the course of the study. Study ended one hour post operatively in the recovery room before patients transfer to the ward, and a total of 115 patients completed the study: 59 in the atropine and 56 in the normal saline group.

Data Analysis and Interpretation: Statistical analysis was done using SPSS version 22. Student t-test was used to compare the change in mean arterial pressure between the two groups and chi square for categorical data. Probability value less than 0.05 was considered as statistically significant.

RESULTS

There were no statistically significant differences in baseline characteristics such as age, weight, height, or ASA status, indicating comparability between groups as shown in table 1 and 2 below.

Table I: Demographic characteristics within randomized groups

Characteristic	Study groups		Total	t-test (p-value)
	Normal saline	Atropine		
	Mean (SD)*	*Mean (SD*)*		*Student t-test p-value*
Age (years)	35.30 ± 12.58	38.25 ± 8.99		0.149
Weight (kg)	66.85 ± 8.68	69.11 ± 8.65		0.184
Height (m)	1.65 ± 0.06	1.64 ± 0.07		0.281
BMI** (kg/m^2)	24.3 ± 2.3	25.5 ± 2.4		0.007

*SD standard deviation
**Body mass index

Surgical procedures and ASA status: Regarding surgical procedures performed, 45 (39.1%) of the patients had myomectomy, 33 (28.7%) had appendectomy, 13 (11.3%) had ovarian cystectomy, 10 (8.7%) had hysterectomy while 7 (6.1%) of the patients had prostatectomy and herniorrhaphy. Eighty-seven (75.7%) and 28 (24.3%) patients belonged to ASA I and II categories of physical status respectively (Table II).

Table II: Surgical procedures and ASA status

Clinical characteristic	Study groups		Total	Chi square (p-value)
	Normal saline	Atropine		
Surgical procedure				19.106 (p = 0.002)
Myomectomy	12 (21.4%)	33 (55.9%)	45 (39.1%)	
Hysterectomy	4 (7.1%)	6 (10.2%)	10 (8.7%)	
Appendectomy	21 (37.6%)	12 (20.3%)	33 (28.7%)	
Prostatectomy	4 (7.1%)	3 (5.1%)	7 (6.1%)	
Herniorrhaphy	4 (7.1%)	3 (5.1%)	7 (6.1%)	
Ovarian cystectomy	11 (19.7%)	2 (3.4%)	13 (11.3%)	
Total	**56 (100.0%)**	**59 (100.0%)**	**115 (100.0%)**	
ASA status				0.144 (p = 0.704)
ASA I	42 (75.0%)	45 (76.3%)	87 (75.7%)	
ASA II	14 (25.0%)	14 (23.7%)	28 (24.3%)	
Total	**56 (100.0%)**	**59 (100.0%)**	**115 (100.0%)**	

Incidence of hypotension

Table III: Incidence of hypotension within groups

Groups	Hypotension		Total
	Yes	No	
Normal saline	11 (19.6%)	45 (80.4%)	56 (100%)
Atropine	4 (6.8%)	55 (93.2%)	59 (100%)
Total	**15 (13.0%)**	**100 (87.0%)**	**115 (100%)**

Chi-square = 4.191, p = 0.041

Table III above showed the distribution of hypotension between the two experimental groups. The incidence of hypotension among participants randomized to the normal saline group was 19.6% compared to 6.8% among the atropine group. The difference was statistically significant (Chi-square = 4.191, p = 0.041).

Side effects of intravenous Atropine: A higher proportion 32 (54.2%) of the atropine group had tachycardia compared to 8 (14.3%) of normal saline group as shown in Table V below. This difference was statistically significant (p < 0.001). All cases of dry mucous membrane 8 (100%) were patients randomized to the Atropine group. This was also statistically significant (p = 0.004) (Table V). Only one patient in the Atropine group reported dilated pupil while no patient reported drowsiness, confusion or cutaneous flush.

Table IV: Side effects in study groups

Side effects	Study groups		Total	Chi square (p-value)
	Normal saline	Atropine		
Dilated pupils				0.957 (p = 0.328)
Yes	0 (0.0%)	1 (1.7%)	1 (0.9%)	
No	56 (100.0%)	58 (98.3%)	114 (99.1%)	
Total	**56 (100.0%)**	**59 (100.0%)**	**115 (100.0%)**	
Tachycardia				20.215 (p < 0.001)
Yes	8 (14.3%)	32 (54.2%)	40 (34.8%)	
No	48 (85.7%)	27 (45.8%)	75 (65.2%)	
Total	**56 (100.0%)**	**59 (100.0%)**	**115 (100.0%)**	
Dry mucous membrane				8.307 (p = 0.004)
Yes	0 (0.0%)	8 (13.6%)	8 (7.0%)	
No	56 (100.0%)	51 (86.4%)	107 (93.0%)	
Total	**56 (100.0%)**	**59 (100.0%)**	**115 (100.0%)**	

Comparison of Pulse Rate

Figure 1 shows the comparative pulse rate (PR) trends between atropine group and for the normal saline group during surgery [intraoperative period]. The PR in the atropine group was higher than the PR for the normal saline group most of the time points. The test of within-subject effect on PR was significant over the course of the surgery (F = 1.880, p = 0.026). This effect was not significantly modified (dependent) on the treatment group of study participants (interaction term F = 0.380, p = 0.999).

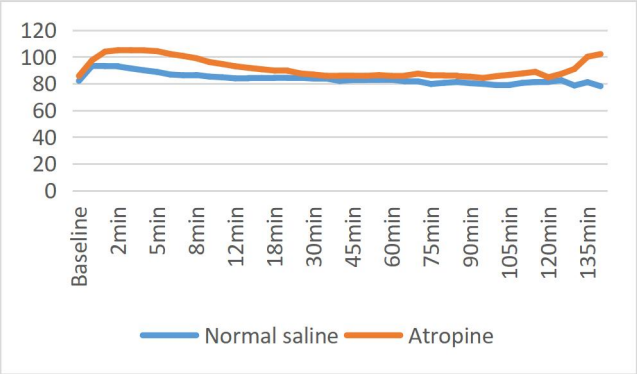

Figure 1: The comparative mean pulse rates distribution between groups

Comparison of MAP: Figure 2 shows the mean arterial pressure (MAP) trend between atropine group and for the normal saline group during the intraoperative periods. The MAP for the atropine group was higher than the MAP for the normal saline group for most of the time points. The test of within-subject effect on MAP (General linear model mixed repeated measures ANOVA analysis) was significant over the course of the surgery (F = 3.795, p < 0.001). This effect was significantly modified (dependent) on the treatment group of study participants (interaction term F = 2.114, p = 0.01).

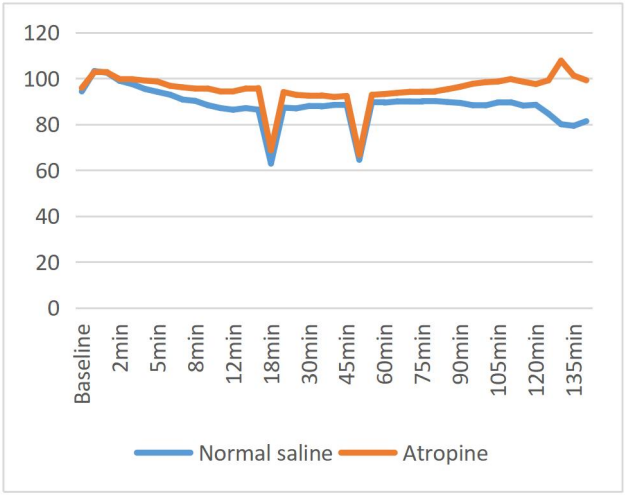

Figure 2: The comparative mean MAP distribution between normal saline and atropine groups

DISCUSSION

This study demonstrated that the administration of intravenous atropine 0.6 mg immediately after induction of spinal anaesthesia, significantly increased the mean arterial pressure (MAP) compared to normal saline administration. This effect can be attributed to atropine's vagolytic action, which blocks M2 muscarinic receptors[11] in the heart, leading to increased heart rate, cardiac output, and consequently, mean arterial pressure. Intravenous atropine administration primary effect is on increasing heart rate as an anticholinergic medication, by blocking the action of the vagus nerve on the heart (positive chronotropic effect). This can result in an increase in cardiac output, which may lead to an increase in blood pressure, particularly if there was bradycardia before atropine administration. Additionally, the atropine group received a higher volume of intravenous fluids than the normal saline group, which also contributed to better hemodynamic stability, a finding consistent with previous studies[14] that highlight the role of fluid loading in mitigating hypotension after spinal anaesthesia.

The results of this study align with those of Gelaw et al[15] who found a significantly higher MAP in the atropine group in a cohort of geriatric patients undergoing urological surgeries. This confirms the efficacy of atropine in managing spinal anaesthesia-induced hypotension. Similarly, Sigdel[7] observed a higher MAP in the atropine group, especially during the initial minutes post-spinal anaesthesia. Notably, this present study's randomized, double-blinded design helped mitigate potential biases present in earlier studies, offering a more robust conclusion.

In terms of hypotension incidence, the atropine group exhibited a significantly lower rate (6.8%) compared to the normal saline group (19.6%), with a relative risk reduction of 65%. This suggests that atropine effectively reduces the occurrence of hypotension, likely due to its impact on the heart rate and cardiac output, which counters the hypotensive effects of spinal anaesthesia. These findings are consistent with other studies, including those by Sigdel[16] and Nze,[17] who also found a lower incidence of hypotension in the atropine group. While severe hypotension was less frequent in the atropine group (1.7%) compared to the normal saline group (7.1%), the difference was not statistically significant, implying that atropine may not significantly affect the severity of hypotension. This contrasts with some studies, such as that by Hirabayashi et al,[18] which found no effect of atropine on blood pressure changes in a premedication model, possibly due to differences in atropine administration routes and timing.

Heart rate analysis revealed that the atropine group had a consistently higher pulse rate, which is consistent with atropine's well-known vagolytic effect. This finding is corroborated by previous studies, such as those by Sigdel[16] and Lim,[19] who reported higher heart rates in atropine-treated groups compared to controls. However, contrasting findings from Ahn et al[20] suggest that the interaction of atropine with other sedatives, such as dexmedetomidine, may alter its hemodynamic effects.

Regarding side effects, tachycardia was the most common adverse effect, occurring in 54.2% of the atropine group, and dry mucous membranes were also noted in 13.6% of patients. These side effects were mild and not associated with any serious complications, indicating that intravenous atropine is generally safe in this context.

In conclusion, the study confirms that intravenous atropine (0.6 mg) significantly reduces the incidence of spinal anaesthesia-induced hypotension in patients undergoing lower abdominal surgery. While the reduction in severity of hypotension was not statistically significant, the benefits in terms of MAP stability and low incidence of severe hypotension support the use of atropine as a preventive measure. The most common side effects—tachycardia and dry mucous membranes—were mild and manageable, making atropine a safe adjunct in a resource constrained clinical setting.

LIMITATIONS

The blood pressure measurement in this study was done by non-invasive oscillatory method which cannot give real time minute to minute blood pressure measurement like the invasive arterial blood pressure measurement.

Another limitation was the exclusion of previously randomized patients who had failed spinal or patchy blocked.

Conflicts of Interest: There are no conflicts of interest declared.

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